[SPECIFICATION]

[Title of the Invention]

METHOD FOR FORMING PATTERN USING PRINTING PROCESS

[Brief description of the Drawings]

Figure 1 is a plane view showing a structure of a general liquid crystal display device;

Figure 2 is a cross-sectional view in line I-I' direction showing structures of a thin film transistor and a storage capacitor of the liquid crystal display device showing in Figure 1;

Figures 3a~3c are views illustrating a method for forming a pattern in a gravure offset printing process as a first embodiment of the present invention;

Figures 4a~4c are views illustrating a method for forming a pattern in a direct contact printing process according to a second embodiment of the present invention; and

Figures 5a~5c are views illustrating a method for forming a pattern in a micro contact printing process according to a third embodiment of the present invention.

**** Explanation for the major reference numerals ****

220,320 : substrate	210,310 : opening
221,321 : etching subject layer	230,330 : master
240 : resist supplying roll	340 : doctor blade
222,322 : resist pattern	

[Detailed description of the invention]

[Object of the invention]

[Field of the invention and background art]

The present invention relates to a method for forming a pattern using a printing process, and particularly, to a method for forming a pattern in order to form a fine pattern of a liquid crystal display device accurately.

In display devices, particularly in flat panel display devices, pixels are arranged in a matrix. Further, in flat panel devices, such as LCD devices, an active device, such as Thin Film Transistors (hereinafter, TFTs) are positioned in respective pixels for driving the pixels in the display devices. This method of driving the display device is called the active matrix driving method because the active devices are arranged in the respective pixels aligned in a matrix form.

Figure. 1 is a plan view of a pixel in a related art LCD device using the active matrix method. The active device is a TFT 10. As shown in FIG. 1, gate lines 2 arranged lengthwise and data lines 4 arranged widthwise define a pixel. The TFT 10 for independently controlling the driving of the respective pixel is formed near where one of the gate lines and one of the data lines cross over each other. The TFT 10 includes a gate electrode 2a, which is connected with one of the gate lines 2, a semiconductor 5 that is formed on the gate electrode 2a, and source and drain electrodes 4a and 4b that are formed on the semiconductor layer 5. The TFT 10 is activated when a scan signal is applied to the gate electrode 2a by one of the gate lines 2. In the pixel, a pixel electrode 7, which is connected to the drain electrodes 4b, is supplied with an image signal through the source and drain electrodes 4a and 4b when the semiconductor layer 5 is activated by the gate electrode 2a. The pixel electrode 7 is connected with the drain electrode 4b

through the first contact hole 8a. A storage line 6 and a storage electrode 11, which overlaps the storage line 6, are positioned in the pixel defined by the gate line 2 and the data line 4 to form a storage capacitor Cst. The storage electrode 11 is connected with the pixel electrode 7 through a second contact hole 8b.

Figure 2 is a cross-sectional view taken along section line I-I' of Figure 1 showing a TFT 10 and storage capacitor Cst positioned inside the pixel. As shown in FIG. 2, the TFT 10 includes a substrate 1 made of transparent insulating material, such as glass, a gate electrode 2a formed on the substrate 1, a gate insulating layer 13 deposited over the entire substrate 1, a semiconductor layer 5 formed on the gate insulating layer 13 and source/drain electrodes 4a and 4b formed on the semiconductor layer 5, and a passivation layer 15 formed on the source/drain electrodes 4a and 4b to protect the device, and a pixel electrode 7 connected with the drain electrode 4b through the first contact hole 8a.

The storage capacitor Cst includes a storage line 6 formed during the same series of patterning processes as the gate electrode 2a of the TFT, and a storage electrode 11 formed during the same series of patterning processes as the source and drain electrodes 4a and 4b. A gate insulating layer 13 is formed between the storage line 6 and storage electrode 11. A second contact hole 8b for exposing a part of the storage electrode 11 is formed in the passivation layer 15. The storage electrode 11 is electrically connected with the pixel electrode 7 through the second contact hole 8b. The storage capacitor Cst charges via a gate voltage while a gate signal is applied to the gate electrode 2a, and then holds charge until the gate electrode 2 is selected in the next frame to prevent voltage change of the pixel electrode 7. At that time, sizes of the first and second contact holes 8a and 8b for electrically connecting the drain electrode 4b and the storage

electrode 11 to the pixel electrode 7 are a few μm respectively.

The LCD device as above is fabricated by a photo mask process, and the photo mask process comprises a series of processes such as photo-resist application, arrangement and exposure, development, cleaning, etc.. Especially, in the exposure process, processes of disposing the mask on original position, aligning the mask and the substrate as matching align keys of the mask and the substrate, and radiating light source are proceeded in order, and at that time, it is difficult to make an accurate alignment due to a limitation of the exposing equipment. Therefore, there is a limit to form a fine pattern requiring high degree of accuracy, and a plurality of photo processes should be repeated, and therefore, the productivity is lowered.

[Problem to be solved by the invention]

Therefore, an object of the present invention is to provide a method for forming a pattern on a liquid crystal display device with one process in a printing method.

Another object of the present invention is to provide a method for forming a pattern which is able to simplify equipment and to form a fine pattern by applying a direct contact or a micro contact printing method using a master.

To achieve the objects of the present invention, as embodied and broadly described herein, there is provided a method for forming a pattern including: a step of providing a substrate including an etching object layer; a step of laying a master having an opening selectively on the etching object layer; a step of filling resist in the opening of the master; and a step of separating the master from the substrate.

In another aspect of the present invention there is provided a method for forming a pattern including: a step of preparing a substrate on which an etching object layer is formed; a step of laying a master having an opening on an area corresponding to a position of the etching object layer where the pattern will be formed on the etching object layer; a step of applying resist on the master; a step of contacting a doctor blade on the master on which the resist is applied and flattening the surface of the master to fill the resist in the opening and to remove the resist remained on the surface of the master; a step of hardening the resist; and a step of forming a resist pattern on the etching object layer by separating the master from the substrate.

In another aspect of the present invention there is provided a method for forming a pattern including: a step of preparing a substrate on which an etching object layer is formed; a step of laying a master having an opening formed on an area corresponding to a position of the etching object layer where the pattern will be formed on the etching object layer; a step of contacting a resist supplying roll on the master and rotating it to fill the resist on the opening of the master where the resist supplying roll passed over; a step of hardening the resist; and a step of forming a resist pattern on the etching object layer by separating the master from the substrate.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

[Construction of the invention]

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

Figures 3a to 3c are views illustrating a method for forming a resist pattern on a substrate by using a printing method in accordance with an exemplary embodiment of the present invention.

As shown in Figure 3a, after providing cliché 100 in which grooves 102 are formed in shapes and positions corresponding to a pattern to be formed on a substrate, a resist 103 is filled into the cliché 100. For example, the an amount of the resist that will more than fill the grooves 102 is disposed upon the surface of the cliché 100 and is pulled into the grooves 102 by a doctor blade 110 to flatten the resist into the grooves and then excess resist is whisked off. The doctor blade 110 should be pulled in a direction that is along the longest length of groove. Otherwise, if the doctor blade 110 is pulled in a direction perpendicular or not parallel to longest length of the groove, the resist might not fill the groove 102 smoothly along its longest length such that subsequent processes can remove resist from the cliché 100.

As shown in Figure 3b, the resist 103 filled into the groove 102 of the cliché 100 is transferred onto the surface of a rotating printing roll 120 when printing roll 120 is rolled across the surface of the cliché 100. The printing roll 120 has the same width as that of the panel of the display device to be fabricated. Further, the printing roll has a circumference that is identical to the length of the panel of the display device to be fabricated. Therefore, the resist 103 filled into the groove 102 of the cliché 100 is transferred onto the circumferential surface of the printing roll 120.

As shown in Figure 3c, the printing roll 120 with the resist 103 on the

circumferential surface is rolled across the surface of an etching object layer 131 formed on a substrate 130 to apply the resist 103 to the etching object layer 131, and a resist pattern 107 is formed by drying the applied resist 107 with a scanning UV light or applying heat. Preferably, the pattern 107 necessary for the entire patterning process step for the etching object layer can be formed over the entire substrate 120 of the display device by rotating the printing roll 120 once across the etching object layer 131. Accordingly, since the cliché 100 and printing roll 120 can be fabricated according to the size of the preferable display device and the pattern can be formed on the substrate 130 by a one time application, the patterning of a large-area display device for an etching object layer can be performed in a single series of patterning processes.

The etching object layer 131 can be a metal layer for forming a metal pattern, such as the gate electrodes of the TFTs and the storage electrode. In another example, the metal layer can be for forming the source/drain electrodes, gate lines and data lines. In the alternative, the etching object layer can be an insulating layer, such as SiO_x or SiN_x, or a semiconductor layer.

After forming the resist pattern 107 as above on the metal layer or the insulating layer, the metal layer or the insulating layer is etched in a general etching process to form the metal layer (that is, electrode structure) or the insulating layer (for example, a contact hole) of desired pattern.

The resist pattern can be formed in the above printing process with one process, and especially, the processes are simple and the processing time can be reduced when it is compared to the conventional photo mask process.

However, the method for forming the pattern in the gravure offset printing method has a disadvantage that an interface property between the etching object

layer and the resist pattern is inferior. That is, when the resist is transferred from the cliché 100 to the printing roll 120, the resist is not separated smoothly from the recess 102, and therefore, some of the resist is remained on the recess 102 and the surface of the resist transferred on the printing roll 120 is not even. Therefore, a gap may be generated on the interface between the substrate 120 and the resist pattern when the resist is re-transferred onto the substrate 120. As described above, in case that the gap is generated on the interface, the etchant is leaked into the gap when the pattern is formed by etching the etching object layer 131 by the etching process, and therefore, the etching object layer 131 of undesired portion is etched to cause inferiority of the product.

Also, according to above printing method, the resist filled in the cliché 100 is not transferred directly onto the substrate 130, but the processes of transferring the resist on the printing roll 120 and applying the resist onto the substrate are performed. Therefore, there is a limit to form a fine pattern of high precision.

To achieve the above problem, the present invention provides a method for forming a pattern which is able to form the fine pattern of high precision by forming a patterned resist directly on the substrate using a master on which an opening is partially formed.

Figures 4a~4c are views illustrating a method for forming a pattern using a direct contact printing method which is able to solve the above problem according to a second embodiment of the present invention. As shown in Figure 4a, a substrate 220 on which an etching object layer 221 is formed is provided, and a master 230 is contacted thereon. At that time, an opening 210 is selectively formed on the master 230, and it is corresponded to a pattern area of the etching object layer 221 which will be formed by later processes. Then, as shown in Figure

4b, a resist supplying roll 240 is contacted to the master 230, and then, the roll 240 is rotated to fill the resist 204 in the opening 210. At that time, the resist 204 is applied on the opening 210 and the surface of the master 230, the doctor blade (not shown) is contacted to the master 230 and pushed to flatten the surface, and thereby the resist 204 is filled only in the opening 210 and the resist applied on the master 230 can be removed.

As described above, after filling the resist 104 having same thickness in the opening 210 of the master 230, the UV or heat is radiated to dry the resist 204 as shown in Figure 4c. Then, the master 230 is separated from the substrate 220 to form the resist pattern 222. At that time, since the shape of the resist pattern 222 is changed when the master 230 is shaken, the master 230 should be handled with care so as not to shake the master 230.

According to the direct contact printing method as above, the resist pattern is directly formed on the substrate without the transferring process of the resist, and therefore, the interface property between the substrate and the resist is superior and the pattern of high precision can be formed accurately.

However, in case that the etching object layer 221 has the stepped portion due to the lower layer, the substrate is damaged if the master is directly contacted to the etching object layer 221. Therefore, in case that the surface of the etching object layer 221 has the stepped portion, the micro contact printing method which does not contact the master directly onto the substrate, but disposes the master with a few μm interval is used.

The micro contact printing method has nearly same pattern forming method as that of the direct contact printing method, and has a difference in that the master is separated from the substrate with a few μm.

Figure 5a~5c are views illustrating the method for forming pattern using the above micro contact printing method. As shown in Figure 5a, a substrate 320 on which an etching object layer 321 is formed is provided, and then, a master 330 having an opening 310 formed on an area corresponding to a position where the pattern will be formed is disposed on a position apart from the substrate 320 as far as distance d. At that time, the apart distance should be a few μm, and the master 330 should be disposed in parallel with the substrate. Next, as shown in Figure 5b, the resist 304 is filled in the opening 310 and in the apart area connected with the opening 310. The filling method of the resist is same as that of the previous embodiment, and a method for applying the resist 304 on the master 330 in advance and for flattening it with the doctor blade 340 is shown in Figure. At that time, a metal precursor such as Ag paste or a conductive polymer may be used instead of the resist. After that, as shown in Figure 5c, UV or heat is radiated to dry the resist, and then, the master 330 is separated from the substrate 320 to form the resist pattern 322. Next, the etching object layer 321 is etched using the resist pattern 322 as a mask to form the desired pattern. For example, in case that the etching object layer 321 is the metal layer, all metal layers constructing the liquid crystal display device, that is, the gate electrode, the gate line, source/drain electrodes, the data line and the pixel electrode, etc. are formed. In addition, in case that the etching object layer is an inorganic layer such as SiOx or SiNx or an organic layer such as BCB, a contact hole is formed. Besides, the etching object layer may be a semiconductor layer.

In the above micro contact printing method, the master is not directly contacted to the substrate, and therefore, contamination of the substrate can be reduced when compared to the direct contact printing method. That is, even if the

master is thoroughly cleaned before the printing process, the impurities are remained on the surface of the master, and then, the substrate is contaminated. However, when the master is separated from the substrate, the contamination of the substrate can be prevented.

[Effect of the invention]

As described above, according to the present invention, the resist pattern is formed in one printing process to simplify the processing equipment and to reduce the processing time and cost, and therefore, the producing efficiency can be improved. Also, according to the present invention, the resist pattern is directly formed on the substrate without using the printing roll, and therefore, the pattern of high precision can be formed accurately.

What is claimed is:

1. A method for forming a pattern comprising:

a step of providing a substrate including an etching object layer;

a step of laying a master having an opening selectively on the etching object layer;

a step of filling resist in the opening of the master; and

a step of separating the master from the substrate.

2. The method of claim 1, wherein the step of filling the resist in the opening of the master comprises:

a step of contacting a resist supplying roll on the master; and

a step of filling the resist in the opening of the master where the resist supplying roll passed over, by rotating the resist supplying roll.

3. The method of claim 1, wherein the step of filling the resist in the opening of the master comprises:

a step of applying the resist on the master; and

a step of contacting a doctor blade on the master on which the resist is applied, and pushing the doctor blade evenly to fill the resist in the opening and remove the resist remained on the surface of the master.

4. The method of claim 1, wherein the master is apart a few μm from the substrate.

5. The method of claim 1, wherein the etching object layer includes a metal layer.

6. The method of claim 1, wherein the etching object layer includes an insulating layer made of SiOx or SiNx.

7. The method of claim 1, wherein the etching object layer is a semiconductor layer.

8. The method of claim 1 further comprising a step of hardening the resist.

9. A method for forming a pattern comprising:

a step of preparing a substrate on which an etching object layer is formed;

a step of laying a master having an opening on an area corresponding to a position of the etching object layer where the pattern will be formed on the etching object layer;

a step of applying resist on the master;

a step of contacting a doctor blade on the master on which the resist is applied and flattening the surface of the master to fill the resist in the opening and to remove the resist remained on the surface of the master;

a step of hardening the resist; and

a step of forming a resist pattern on the etching object layer by separating the master from the substrate.

10. The method of claim 9, wherein the master is apart a few μm from the substrate.

11. A method for forming a pattern comprising:

a step of preparing a substrate on which an etching object layer is formed;

a step of laying a master having an opening formed on an area corresponding to a position of the etching object layer where the pattern will be formed on the etching object layer;

a step of contacting a resist supplying roll on the master and rotating it to fill the resist on the opening of the master where the resist supplying roll passed over;

a step of hardening the resist; and

a step of forming a resist pattern on the etching object layer by separating the master from the substrate.

12. The method of claim 11, wherein the master is apart a few μm from the substrate.